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Investigation of domain walls in PPLN by confocal raman microscopy and PCA analysis

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Abstract
Confocal Raman microscopy (CRM) is a powerful tool for investigation of ferroelectric domains. Mechanical stresses and electric fields existed in the vicinity of neutral and charged domain walls modify frequency, intensity and width of spectral lines [1], thus allowing to visualize micro- and nanodomain structures both at the surface and in the bulk of the crystal [2,3]. Stresses and fields are naturally coupled in ferroelectrics due to inverse piezoelectric effect and hardly can be separated in Raman spectra. PCA is a powerful statistical method for analysis of large data matrix providing a set of orthogonal variables, called principal components (PCs).

PCA is widely used for classification of experimental data, for example, in crystallization experiments, for detection of small amounts of components in solid mixtures etc. [4,5]. In Raman spectroscopy PCA was applied for analysis of phase transitions and provided critical pressure with good accuracy [6].

In the present work we for the first time applied Principal Component Analysis (PCA) method for analysis of Raman spectra measured in periodically poled lithium niobate (PPLN). We found that principal components demonstrate different sensitivity to mechanical stresses and electric fields in the vicinity of the domain walls. This allowed us to separately visualize spatial distribution of fields and electric fields at the surface and in the bulk of PPLN.

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